AbstractID: 10383 Title: Anisotropic edema modelling for permanent prostate implants

Purpose:
To develop an edema model for application in permanent prostate implant dosimetry that reflects edema spatial anisotropy and time−resolution behaviors observed in clinical MRI data.

Method and Materials:
The basic manifestation of edema was represented as a trio of variations in Cartesian components of the distance, $r_i(t)$; i=1:3, from a radioactive seed to a dose calculation point; specifically $r_i(t) = (r_0)_i \cdot [f_i(t)]^{\alpha_i}$. Here $(r_0)_i$ are distance components in the absence of edema, $f_i(t)$ edema time−resolution functions, and α_i quantifiers of the directional contributions to edema volume subject to the constraint $\alpha_1+\alpha_2+\alpha_3=1$. Serial MRI data from our institution for n=40 prostate implant patients is well characterized by the parameters $\alpha_1=0$, $\alpha_2=\alpha_3=1/2$, and the function $f_i(t) = (1+\Delta(1-t/T))$; $t<T$; i=1:3. Hence these parameters and time−resolution function were incorporated in the model. Next, the cumulative dose from a seed to a calculation point was expressed according to the TG-43 formalism (using the anisotropy constant) as $D(\vec{r}) = S_K \cdot \Lambda \cdot r_0^2 \cdot \bar{\phi}_{an} \int_0^\infty |\vec{r}(t)|^{-2} \cdot g(|\vec{r}(t)|) \cdot e^{-\lambda t} dt$, where λ is the radionuclide decay constant and the other variables are defined as per TG-43. The integrand was then expanded in even powers of $|\vec{r}(t)|$, and the resulting integral in each term of the expansion evaluated to yield either a closed−form analytic function or a convergent series. Numerical evaluation of constituent terms in the dose expansion was done in MatLab to assess functional behavior.

Results:
The number of terms in the expansion of $D(\vec{r})$ are few, and all are well-behaved numerically. For those terms involving convergent series, convergence is rapid and so only a small number of terms need to be evaluated. Based on these favorable properties, MatLab−based dose calculation software is currently being developed to investigate applications to clinical dosimetry.

Conclusion:
A new edema model for permanent prostate implant dosimetry incorporating spatial anisotropy has been formulated. Clinical application is pending.

Conflict of Interest (only if applicable):